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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE
Scientific and Technical Sub-Committee
Twenty-seventh session

REPORT OF THE WORKING GROUP ON THE USE OF NUCLEAR POWER SOURCES IN OUTER SPACE ON THE WORK OF ITS EIGHTH SESSION

I

1. The Working Group on the Use of Nuclear Power Sources in Outer Space, reconvened in accordance with General Assembly resolution 44/46, paragraph 12, held its eighth session at United Nations Headquarters from 5 to 8 March 1990. Mr. J. H. Carver (Australia) served as its Chairman.

2. The Working Group held 5 meetings. A list of the experts who attended the session is given in document A/AC.105/C.1/WG.5/INF.1.

3. The Working Group had before it replies from Austria, Czechoslovakia, Finland, the Federal Republic of Germany, Japan, Pakistan, Sweden, United Arab Emirates and the Union of Soviet Socialist Republics, to the Secretary-General's note verbale dated 30 June 1989 (A/AC.105/C.1/WG.5/L.24, Add.1-3 and Add.2/Corr.1) as well as working papers and studies submitted by Canada (A/AC.105/C.1/WG.5/L.26) and the Federal Republic of Germany (A/AC.105/C.1/WG.5/L.25 and 27).

4. Following an exchange of views, the Working Group adopted the present report at the conclusion of its meeting on 8 March 1990.

II

5. The Working Group reviewed the conclusions it had reached in its previous reports, in particular, that of its third session (A/AC.105/287, annex II).

6. The Working Group noted that countries launching nuclear power sources (NPS) should conduct safety assessments of those systems and should make those assessments publicly available. In particular, the Working Group took note of the oral statement of the safety assessment process for the Galileo interplanetary mission as described by the United States of America.

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7. Some delegations stated that since there was a reasonably high probability of collision of spacecraft carrying NPS with space debris in the altitude band of 800 to 1,000 km, it was essential to study this question and to develop methods to minimize possible radiological hazards. This might require the development of new technologies for prevention of the creation of new debris, monitoring of the situation or even removal of space debris from orbit.

8. The view was expressed that the consequences of a spacecraft with NPS on board colliding with space debris could be studied using a variety of collision models. The risk of collisions should be studied particularly in the altitude range of 800 to 1,100 km, where most nuclear sources, together with a large number of other satellites and the maximum density of space debris, are to be found. Since different types of objects could collide, methods have to be developed for calculating the effects of elastic and non-elastic impacts, and of spacecraft destruction with the scattering of secondary fragments. Numerical computation could reveal changes in the orbital lifetimes of the resulting objects and their interaction with the atmosphere.

9. Some delegations emphasized that space missions with NPS should be justified by the radiation protection criteria recommended by the International Commission on Radiological Protection (ICRP) in terms of benefit versus risk. The view was expressed that the results of this justification procedure should be made publicly available.

10. Some delegations were of the view that if there is a need for guidance relating to quantitative dose limits, the international organizations dealing with radiological health questions in general, in the first place the IAEA, should be the proper bodies to develop such advice.

11. Other delegations were of the view that the ICRP recommendations were especially important in the work to develop NPS safety principles and also recalled the mandate provided to the Committee on the Peaceful Uses of Outer Space and its Sub-Committees to develop such principles.

12. It was observed that there was not an urgent need to seek quantitative limitations to the amount of radioactive material either in individual nuclear devices or in the total radioactive inventory in orbit, as long as the number of space missions employing NPS was small and the nuclear devices had a radioactivity content similar to that currently used.

13. The Working Group noted with appreciation the above-mentioned papers submitted by Canada, the Federal Republic of Germany and the Union of Soviet Socialist Republics (A/AC.105/C.1/WG.5/L.24/Add.2, and L.25-27).

14. During the consideration of document A/AC.105/C.1/WG.5/L.27, a presentation was made of the provisions contained in document A/AC.105/C.2/L.173, and a proposal was made that Principle 3 as contained in that document be supplemented to the effect that as soon as technology permits, any State launching a space object with a nuclear power source on board shall include, as part of the component of the space object containing the nuclear power source, an impact position indicator,

that, for example, will transmit electronic signals to facilitate location of the impact point with a high degree of accuracy, and provide time of impact on the Earth's surface, identify the launching State and the space object in question.

15. The Working Group agreed on the following recommendations for the safe use of nuclear power sources in outer space:

In order to minimize the quantity of radioactive material space and risks involved, the use of nuclear power sources in outer space should be restricted to those space missions which cannot be operated by non-nuclear energy sources in a reasonable way.

1. Design goals for radiation protection

1.1 The general radiation safety objective for NPS in space is to protect individuals, population as a whole and the biosphere against radiological hazards. Therefore, the design of NPS should ensure, with a high degree of confidence, that the hazards - in all foreseeable circumstances, operational or accidental - are kept below an acceptable level.

The design of NPS should also ensure with high reliability that radioactive material does not significantly pollute outer space.

1.2 During normal operation of NPS, including re-entry from the sufficiently high orbit (SHO),* the appropriate radiation protection objective for the public recommended by the International Commission on Radiological Protection (ICRP) should be observed. It is recommended that during such normal operation there should be no significant radiological exposure.

1.3 To limit exposures in accident scenarios, the design of the NPS safety system should take into account relevant international guidelines recommended by the International Commission on Radiological Protection (ICRP).

The design goal for the NPS safety system should be with a high degree of confidence a regional limitation of radiation exposure and a limitation of the individual dose to the principal limit of 1 mSv in a year. However, it is permissible to use a subsidiary dose limit of 5 mSv in a year for some years, provided that the average annual effective dose equivalent over a lifetime does not exceed the principal limit of 1 mSv in a year. Future modifications of the recommendations of ICRP should be applied.

The NPS safety system should also ensure that the probability of serious radiological consequences is extremely small.

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* As defined in subparagraph 2.1.

1.4 Important safety systems shall be designed, constructed and operated in accordance with the general concept of defense in-depth, which refers, for example, to the successive barriers containing radioactive materials of the NPS.

Pursuant to this concept, any foreseeable failure or malfunction of a device that is important for safety must be capable of being corrected or counteracted by another device or by another action, possibly automatic.

The reliability of important safety systems shall be ensured, inter alia, by redundency, physical separation, functional isolation and adequate independence of their components.

Other measures should also be taken to raise the level of safety.

1.5 For NPS-re-entries into the Earth's atmosphere, which may occur after a malfunction in orbital operations, the launching State should provide technical support to identify the location of re-entry and impact, to detect the re-entered radioactive material and, on request, to carry out retrieval or clean-up operations.

2. Nuclear reactors

2.1 Considering the risk of re-entry, nuclear reactors are acceptable for operation on interplanetary missions or in sufficiently high orbits (SHO). The SHO is one in which the orbital lifetime is long enough to allow for a sufficient decay of the fission products to about the activity of the actinides. The SHO must be such that the risks to existing and future outer space missions and of collision with other space objects are kept to a minimum. In determining SHO altitude it should be taken into consideration that, in case of destruction of the reactor, the reactor parts should also attain the necessary level of reduction in radio activity before they re-enter the Earth's atmosphere.

2.2 If nuclear reactors are used in low Earth orbits, they should be stored, after their mission, in a SHO.

2.3 Nuclear reactors should only use highly enriched uranium 235 as fuel. The design should consider the radiological decay of the fission and activation products.

2.4 The design and the construction of the nuclear reactor should ensure that it cannot become critical before reaching the operating orbit, during all possible events such as rocket explosion, re-entry, impact on ground or water or submersion in water.

2.5 Nuclear reactors should not be made critical before they have reached their operating orbit or interplanetary trajectory.

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2.6 In view of possible failures in the NPS systems or of satellites during operations in orbit (including operation for transfer into the SHO), there should be a highly reliable operational system to ensure effective and controllable disposal of the reactor. Such measures could be, for example, reserve elements of the systems for reaching the SHO, or other methods to be developed in the future.

3. Isotope generators

3.1 Isotope generators should preferably be used for interplanetary missions and other missions leaving the gravity field of the Earth. They may also be used in Earth orbits if they are stored after mission end in a high orbit. Ultimate disposal would, however, still be required.

3.2 Isotope generator should be protected by a containment system which withstands the heat and the aerodynamic forces during the re-entry in the upper atmosphere under all possible orbital conditions, i.e., also from highly elliptical or hyperbolic orbits if relevant. Upon ground impact, the containment system and the physical form of the isotope should ensure that no radioactive material is scattered (in soluble, volatile, aerosol or micro-particle form) into the environment so that the impact area can be completely cleared of radioactivity by a recovery operation.

16. The Working Group agreed that representatives of States concerned could, in accordance with the work completed up to now by the Working Group, conduct consultations with IAEA on the question of elaborating recommendations concerning the organization and conduct of operations for emergency planning and preparedness in case of accidental re-entry of NPS into the Earth's atmosphere.